

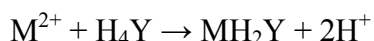
Complexometric titration (sometimes **chelation**) is a form of **volumetric analysis** in which the formation of a colored complex is used to indicate the end point of a titration. Complexometric titrations are particularly useful for the determination of a mixture of different metal ions in solution. An **indicator** capable of producing an unambiguous color change is usually used to detect the end-point of the titration. Complexometric titration are those reactions where a simple ion is transformed into a complex ion and the equivalence point is determined by using metal indicators or electrometrically.

Complex titration with EDTA.

EDTA, **ethylenediaminetetraacetic acid**, has four **carboxyl** groups and two **amine** groups that can act as electron pair donors, or **Lewis bases**. The ability of EDTA to potentially donate its six lone pairs of electrons for the formation of coordinate covalent bonds to metal cations makes EDTA a **hexadentate** ligand. However, in practice EDTA is usually only partially ionized, and thus forms fewer than six coordinate covalent bonds with metal cations.

Disodium EDTA is commonly used to standardize aqueous solutions of transition metal cations. Disodium EDTA (often written as **Na₂H₂Y**) only forms four coordinate covalent bonds to metal cations at pH values ≤ 12 . In this pH range, the amine groups remain protonated and thus unable to donate electrons to the formation of coordinate covalent bonds. Note that the shorthand form **Na_{4-x}H_xY** can be used to represent any species of EDTA, with **x** designating the number of acidic protons bonded to the EDTA molecule.

EDTA forms an octahedral complex with most 2+ metal cations, M^{2+} , in aqueous solution. The main reason that EDTA is used so extensively in the standardization of metal cation solutions is that the formation constant for most metal cation-EDTA complexes is very high, meaning that the equilibrium for the reaction:



lies far to the right. Carrying out the reaction in a basic buffer solution removes H^+ as it is formed, which also favors the formation of the EDTA-metal cation complex reaction product. For most purposes it can be considered that the formation of the metal cation-EDTA complex goes to completion, and this is chiefly why EDTA is used in titrations and standardizations of this type.

Indicators

Calmagite and Eriochrome BlackT (EBT) are such indicators that change from blue to pink when they complex with calcium or magnesium. The endpoint of a complexometric EDTA titration using either Calmagite or EBT as the indicator is detected as the colour changes from pink to blue.

The endpoint detection in complexometric titration can be done by two methods.

1. Visual Method

One of the most common methods for determination of endpoint owing to its simplicity, least cost and accuracy. Following are some of the visual methods used for determining the end point of the complexometric titrations.

- Metallochromic or PM indicators
- pH indicators
- Redox indicators

2. Instrumental Method

Use of visual methods in determining the endpoint is not free from limitations including inaccuracy or human visual errors. Some instrumental techniques used in endpoint determination are

- Photometry
- Potentiometry
- Miscellaneous methods.

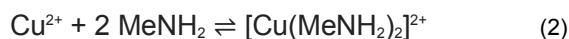
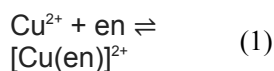
CHELATION

Chelation is a type of bonding of [ions](#) and molecules to metal ions. It involves the formation or presence of two or more separate [coordinate bonds](#) between a [polydentate](#) (multiple bonded) [ligand](#) and a single central atom. These ligands are called chelants, chelators, chelating agents, or sequestering agents. They are usually ^[clarification needed] [organic compounds](#).

Chelation is useful in applications such as providing nutritional supplements, in [chelation therapy](#) to remove toxic metals from the body, as [contrast agents](#) in [MRI scanning](#), in manufacturing using [homogeneous catalysts](#), in chemical [water treatment](#) to assist in the removal of metals, and in [fertilizers](#).

The chelate effect is the enhanced affinity of chelating ligands for a metal ion compared to the affinity of a collection of similar nonchelating (monodentate) ligands for the same metal.

The thermodynamic principles underpinning the chelate effect are illustrated by the contrasting affinities of [copper\(II\)](#) for [ethylenediamine](#) (en) vs. [methylamine](#).



In (1) the ethylenediamine forms a chelate complex with the copper ion. Chelation results in the formation of a five-membered CuC_2N_2 ring. In (2) the bidentate ligand is replaced by two [monodentate](#) methylamine ligands of approximately the same donor power, indicating that the Cu–N bonds are approximately the same in the two reactions.

Uses of Chelates

Chelation therapy is used to remove toxic metals, as in heavy metal poisoning. Chelation is used to formulate nutritional supplements. Chelating agents are used in fertilizers, to prepare homogeneous catalysts, and as contrast agents in MRI scans.

Chelate Examples

- Most biochemical molecules can dissolve metal cations to form chelate complexes. Polynucleic acids, proteins, amino acids, polypeptides, and polysaccharides all act as polydentate ligands.
- The bidentate ligand ethylenediamine forms a chelate complex with the copper ion to form a five-membered CuC_2N_2 ring.
- Almost all metalloenzymes involve chelated metals, typically to cofactors, peptides, or prosthetic groups.
- Hot chemical weathering is typically due to organic chelants extracting metal ions from rocks and minerals.
- Many nutritional supplements are prepared by chelating metal ions to help protect the metal from forming complexes with insoluble salts in the stomach. These supplements thus provide a higher capacity for absorption.
- Homogeneous catalysts, such as ruthenium(II) chloride chelated with a bidentate phosphine, frequently are chelated complexes.
- EDTA and phosphonates are common chelating agents used to soften water.